Chem. Senses 30 (suppl 1): i260–i261, 2005 doi:10.1093/chemse/bjh214

Sensor Fusion for Taste Sensor and Odor Sensor

T. Katsube, S. Umetani, Liqin Shi and Y. Hasegawa

Faculty of Engineering, Saitama University, 255 Shimo-Okubo, Sakura-ku, Saitama 338-8570, Japan

Correspondence to be sent to: T. Katsube, e-mail: katsube@cda.ics.saitama-u.ac.jp

Key words: flavor taste sensor, hierarchical PCA, hierarchical signal processing, odor sensor, principal component analysis, taste sensor, thin film taste sensor

Introduction

Recent research on a taste sensor stimulated the development of several kinds of sensing systems that have the ability to discriminate various tastes of beverages or foods. Most of these sensors involve the concept of global sensing, i.e. non-specifically detected signals are analyzed to extract the inherent taste characteristics (Toko, 1996). The sensor fusion technique extends the global sensing concept by taking into consideration broader-range signals obtained by various sensing devices and measurement methods as well as intelligent signal processing.

In order to develop a high-quality taste sensor, we investigated a sensor fusion by taking into consideration the information obtained by odor sensors. Transient response signals such as step signal responses or AC signal responses are considered, in addition to stationary responses and these different dimension signals are analyzed using hierarchical principal component analysis (PCA) to produce highly sensitive and high-quality sensing systems.

Sensors and measurements

We have developed a taste sensor using commercially available ion sensors and it has been successfully applied to discriminate various kinds of beverages and foods (Katsube, 2002). As an extension of this research, we have recently developed a thin film type taste sensor integrated on a single chip substrate (Zhou *et al.*, 2003) and this was applied to construct a hybrid taste sensor by combining it with an odor sensor. For signal detection, both DC (stationary) and AC (frequency) responses are taken into consideration to extract the taste information.

The odor sensor was constructed with metal oxide semiconductor gas sensors combined with an appropriate signal processing method. As the signal detection, the transient response (step signal response) is utilized as well as stationary response.

Signal processing method and results

Different dimension signals obtained by taste and odor sensors were analyzed using hierarchical signal processing. The analysis procedure is shown in Figure 1. First, the data obtained by various measurement methods were analyzed to extract the principal component (PC) projections. And then, separately projected spaces were combined to obtain hybrid PC projections. As for the taste sensor, measured signals of stationary and frequency response were separately analyzed and the PC spaces obtained were combined to produce hybrid PC space, i.e. taste projection space. Odor projection space was also calculated by a similar procedure. Finally, flavor taste projection was calculated by hybridizing taste space and odor space together. For the analysis of the hybrid PC projection, appropriate numbers of principal components were selected in such a way that the sum of the contributing rates becomes >95% and these were utilized for the hierarchical PC calculation.

We are now investigating the application of the above-mentioned hierarchical procedure for taste evaluation of various food or drinks such as tea, mineral water, soup and Japanese sake. One of the examples is to estimate the flavor taste of red teas. Figure 2a shows the PCA of taste sensor signals for eight brands of red teas containing both plain tea and lemon tea. As shown in this figure, classification of different brands of teas seems to be attained to a certain extent. However, the samples are roughly separated into two groups, i.e. the straight tea group and lemon tea group, but the discrimination of different brands in each group is insufficient. Figure 2b shows the PCA of odor sensor signals for eight tea brands. In contrast to the taste sensor, the separation between the straight tea and lemon tea groups is not so clear and the discrimination of each brand is also insufficient. However, it should be noted that the odor sensor picks up different information, since the PC patterns are considerably different from those of the taste sensor. Combined analysis of taste PCA and odor PCA is plotted in Figure 2c. Compared with the plots of Figure 2a,b, combined signals seem to be effectively analyzed to represent tea taste. In fact, different brands are better classified in Figure 2c without the information loss of each tea group.

Conclusion

A hierarchical signal processing method was applied to combine different dimension signals and a hybrid taste sensor was constructed by combining taste and odor sensors. As one of the applications, the flavor tastes of red teas were estimated and improved discrimination of different brands was attained. This method will be extended to various sensor fusion problems using both parametric and non-parametric signal processing methods.

References

Katsube, T. (2002) *Development and technology of taste sensor and odor sensor*. Trans. IEE Japan, 122-E, 296–299.

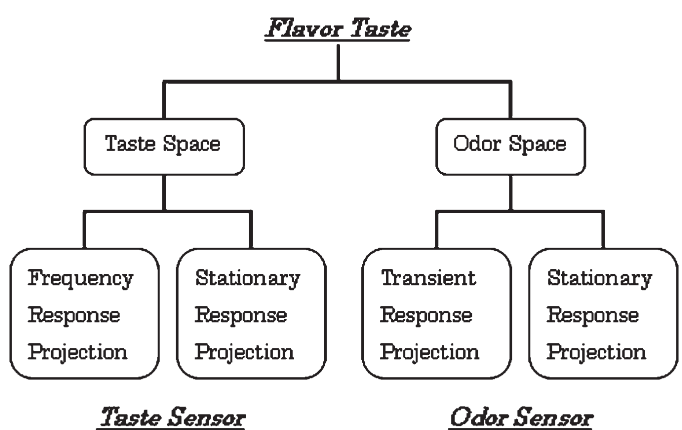

Figure 1 Hierarchical signal processing for taste sensor and odor sensor.

Downloaded from http://chemse.oxfordjournals.org/ by guest on October 3, 2012

 © Oxford University Press 2005; all rights reserved.

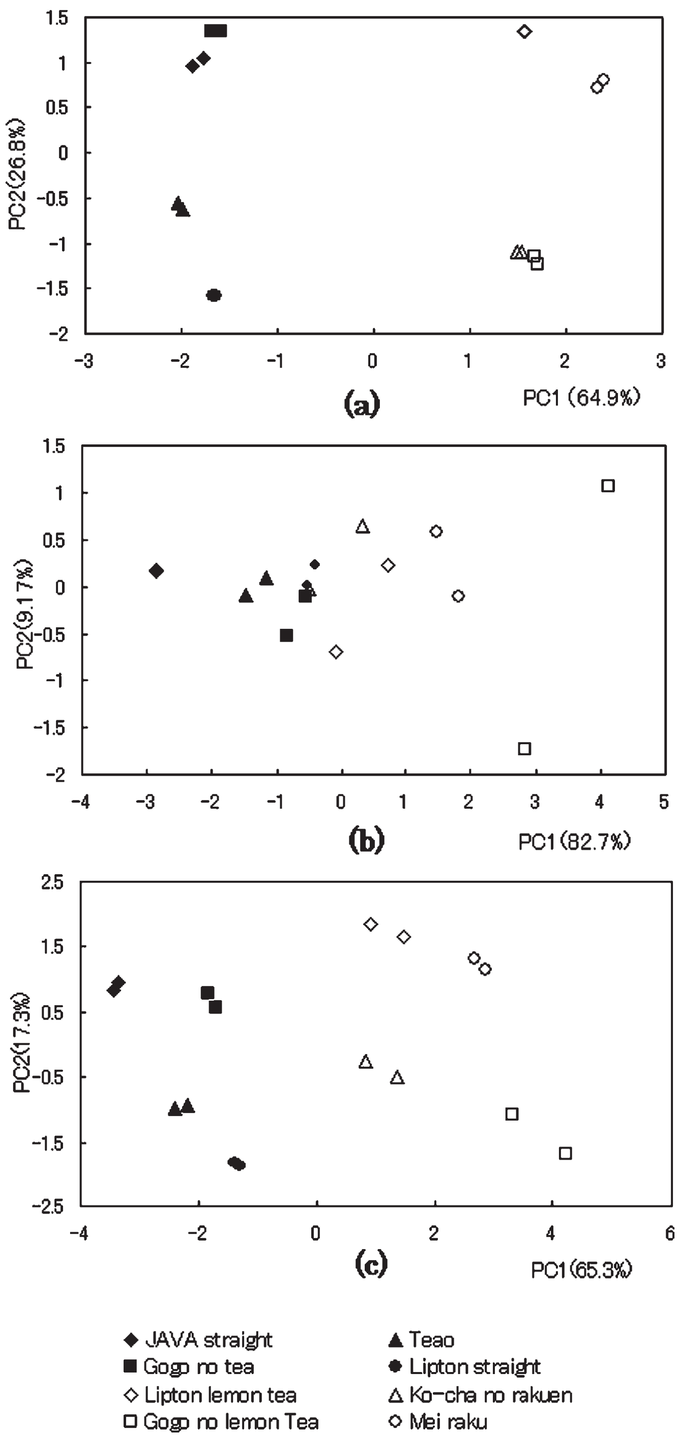

Figure 2 PCA for eight brands of tea for taste sensor **(a)**, odor sensor **(b)** and hybrid sensor **(c)**.

Toko, K. (1996) *Taste sensors with global selectivity*. Mat. Sci. Eng., C4, 69–82.

Zhou, R., Hasegawa, Y., Katsube, T., Sung, Y.W. and Ito, Y. (2003) *Fast response and high sensitive taste sensor using thin film ion electrodes*. Tech. Rep. IEICE, OME2003–28, 23–26.

Downloaded from http://chemse.oxfordjournals.org/ by guest on October 3, 2012